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Science Preservice Teachers' Views on Nature of Science and Technology[1,2]

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ABSTRACT

The aim of the study is to examine the opinions of preservice science teachers concerning the nature of science and to determine whether or not the preservice teachers' opinions differ according to their academic level. A total of 242 preservice science teachers, who studied in the Education Faculty of Inonu University, Turkey, during the 2013-2014 academic year took part in the study. In order to evaluate the opinions of the preservice teachers, eight questions from the Questionnaire of Opinions for Technology and The Nature of Science were used. The original questionnaire is comprised of 20 questions chosen from a larger questionnaire called Opinions Concerning Science, Technology and Society, developed by Aikenhead, Fleming, and Ryan (1989) empirically, and consists of eight categories and 114 multiple-choice questions, and was translated and then adapted into Turkish by specialists in the field. The data obtained were analyzed by means of SPSS 21.0 Statistics program. In analysis of the data, the frequency and percentages were checked and x-square test applied. At the end of the research, it was detected that candidate Science teachers hold a realistic point of view as to the changeability of scientific knowledge, an acceptable point of view as to the definition of science, the interaction of science and technology, and the effect of science and technology on solving social problems. On the other hand, they have an insufficient point of view as to the epistemological condition of hypotheses, theories, laws, and scientific knowledge. According to the academic level factor, it was detected that there was an effect of science and technology on solving social problems, and a dramatic difference as to the epistemological condition of hypotheses, theories, laws, and scientific knowledge. However, there was no dramatic difference seen in terms of the questions on the definition of science, the interaction between science and technology, the changeability of scientific knowledge, and the epistemological condition of scientific knowledge.

Key Words: Nature of science, Science preservice teachers, Opinions on nature of science and technology, View on science technology society, VOSTS

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INTRODUCTION

The effort of humankind to dominate nature and understand the phenomena occurring within it dates as far back as its history. This curiosity and the effort to understand has led humans to a number of behaviors and most importantly to thinking. As a result of the curiosity and thinking, new information have begun to gather and accumulate. In the following periods, the effort to understand the universe and to explain the phenomena in nature have unearthed philosophy; and thus, science and philosophy began to flourish together. The effort of making the phenomena meaningful has ended up with the discovery of different hypotheses and theories. Consequently, new discoveries, information and scientific knowledge through theoretical explanations have gained a basis.

Scientific and technological developments are rapidly increasing these days, enabling information to be produced and disseminated quickly. Individuals reaching information by means of technological devices and a society in which these individuals belong should perceive and interpret information appropriately. Considering how much technology, developed through the knowledge obtained, has eased the lives of humankind, the individuals and the society which these individuals make up should profoundly understand first how scientific knowledge is structured, and accordingly the source and the limits of the information in order to make conscious, social, and personal decisions by applying scientific knowledge. For that reason, the concepts with regards to the nature of science make up the critical and basic component of the view of science-technology-society, which is one of the aspects of science literacy (Lederman, 2004).

Today, the nature of science takes part in various educational reforms and is viewed as a significant educational purpose in the instructional curricula of many countries around the world (Lederman, 2007). It is believed that science teachers will have difficulty in helping their students grasp the scientific concepts perfectly without knowledge of the nature of science (Murcia & Schibeci, 1999; Palmquist & Finley, 1997). However, the studies conducted indicate that teachers and students still have insufficient views concerning the nature of science (Doğan Bora, 2005; Küçük, 2006; Lederman, 1992; Tufan, 2007). On the other hand, the nature of science, which is one of the significant components of scientific literacy, needs to be understood properly by individuals. Where the lack of the knowledge in this field results from and how this deficit will be dealt with can only be compensated for by understanding the opinions of these individuals as to the nature of science. The discovery and development of the lacking knowledge and new educational programs that could be dealt with through such studies will show the views of students, teachers and preservice teachers.

In recent years, there has been increasing interest in the research towards determining the association between the opinions of teachers concerning the nature of science and instructional applications (Mellado, Bermejo, Blanco, & Ruiz, 2007). The concept of "The Nature of Science" is not included in Science Teaching Programs, which was mandatory until 2005 in Turkey. In the program, whose lesson name was changed to Science and Technology and which differs to its forerunners, it was mentioned that Science and Technology teachers were needed who have a vision of raising all students as science and technology literate and have a qualification for teaching the nature of science at primary and secondary schools. For that reason, as from the 2006-2007 academic year in Turkey, the compulsory lesson of "The Nature of Science and The History of Science" was added to the Education Faculties Science Teaching Department. Later, the program was reexamined and the name of the lesson changed to Life Sciences in 2013 (MEB, 2013). In the instructional programs of 2013 and 2018, the concept of Science Literate was used instead of Literate of Science and Technology in the teaching program of 2005; however, there was no remarkable difference in the definition (MEB, 2018).

Importance and Purpose of the Research

The correct understanding of science and technology will contribute to the production of new information and more advanced technologies. Knowledge of the nature of science will help people take part in arguments concerning the questions about science and the processes of making a decision. One of the principal aims of science education is to raise a science literate population; in other words, individuals using the nature of science and the nature of scientific knowledge, by understanding basic science concepts, laws and theorems. In this respect, it is crucial to understand the nature of science in terms of science literacy. In surveys conducted in Turkey and many other countries by using the VOSTS questionnaire, it was noticed that teachers, candidate teachers and students do not have a realistic point of view in terms of many aspects as to the nature of science; on the contrary, they have a conventional stance (Aslan & Taşar, 2013; Dikmentepe & Yakar, 2016; Doğan, Çakıroğlu, Bilican, Çavuş, & Arslan 2011; Duschl & Grandy, 2013; Ersay, 2014; Mıhladız & Doğan, 2012; Yenice, Özden, & Balcı, 2015). The effective teaching of the nature of science to students will also help them understand the importance of the knowledge in terms of life, and which causes societies to change and develop (Wong, 2002). It is important to understand the views of candidate science teachers as to the nature of science and technology as they will have a significant contribution in raising individuals who will work in the fields of science and technology in the future.

The aim of the current study is to examine the views of candidate science teachers in a Science Teaching Department as to the nature of science and technology, and to determine whether or not academic level has an effect on the candidate teachers in terms of the approaches in the nature of science and technology.

METHOD

Model of the Research

In the study, evaluation of the result of a scale application with candidate science teachers was taken into consideration. This general scanning model aimed to examine the views of candidate science teachers as to the nature of science and technology. General scanning models are studies in which present conditions determined by obtaining the opinions of individuals or the groups which they formed in their own circumstances as to the phenomena or events in order to reach a common judgment about the population (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2013).

Population and Sampling

The population of the research consists of candidate teachers continuing their education in the Science Teaching Department of the Education Faculty at Inonu University, Turkey, during the 2013-2014 academic year. As the population has an obtainable quality, there was no need to form a sample group, and the majority of the population was able to be reached. The demographic features of the candidate teachers who joined the study are detailed in Table 1.

Table 1. *Frequency and percentage of candidate teachers according to academic grade level*

Grade	*f*	%
1	42	17.4
2	42	17.4
3	70	28.9
4	88	36.4
Total	242	100.0

In Table 1, of the candidate teachers forming the research group, 17.4% of them were studying in the 1st Grade, 17.4% were 2nd Grade, 28.9% were 3rd Grade, and 36.4% were 4th Grade.

Data Collection Instrument

The questionnaire used in the study is known as "Views on Science-Technology-Society" or VOSTS, which was developed by Aikenhead et al. (1989) in Canada after getting 11,000 high school students who were studying in different levels and socioeconomic regions to write paragraphs including the topics of Science, Technology and Society, and examining data from the interviews performed with them over six years.

Within the scope of the study, 20 articles were chosen in total, belonging to six categories of the 114-question-pool taken from the eight categories of the VOSTS questionnaire. The 20 articles chosen in this process were initially adapted to Turkish and renamed as "BDTÜG", or Opinions Concerning the Nature of Science and Technology (Bilimin Doğası ve Teknoloji Üzerine Görüşler). In the application process, the method of reversing the original was followed, as proposed by Şeker and Gençdoğan (2006), within the eight stage sample adaptation as follows:

1. Translation into Turkish
2. Examining and comparing the translations
3. The method of reversing
4. Giving its first shape to the translation test
5. Application of language validity
6. Statistical analysis concerning language validity
7. Giving its final shape to test translate into Turkish
8. Validity and reliability analysis of the Turkish test

The questions chosen were first translated into Turkish by two experts who have language and field competence; and then, the most suitably agreed translation was chosen and any necessary corrections performed. Afterwards, the two questionnaires were re-translated back into English by two language experts. The language coherence was examined by two science teaching experts and any necessary corrections applied to the Turkish form of the questionnaire. After examination of the final version of the questionnaire by two Turkish linguists who checked the meaning and spelling, any necessary corrections were applied in line with their suggestions.

The BDTÜG questionnaire was first applied to 53 Candidate Science Teachers at Inonu University which was included in the pilot scheme, and then the answers given to the questionnaire were analyzed. The total number of the answers received from the 53 Candidate Science Teachers to the questionnaire, including the 20 articles, was 1,060 (53 x 20). However, only 31 of these answers (2.92%) represented the options of *"I did not understand," "I do not have* *sufficient information to make a choice in this subject"* or *"None of these options represent my personal views,"* which were repeated at the end of each article in the questionnaire. Comparing the rate of the last three options to the literature (Aikenhead, 1988 [12%]; Aslan, 2009 [4.75%]; Lieu, 1997 [5.93%]; Mıhladız, 2010 [2.78%]; Rubba, Schoneweg-Bradford, & Harkness, 1996 [10.03%]), it was seen that the result of the application was one of the lowest values and thus suitable for the study, and was therefore approved and prepared for the main study.

The eight articles from three categories concerning the nature of science and technology of the questionnaire of BDTÜG, consisting of six categories and 20 articles, were included in the research as follows:

- Science and Technology category
  - *Definition of Science*
  - *Correlation between Science and Technology*
- Effect of Science and Technology on Society category
  - *Effect of Science and Technology on the solutions of Social Problems*
- Nature of science category
  - *Changeability of scientific Knowledge*
  - *Hypotheses, theories and laws*
  - *Epistemological condition of Scientific Knowledge (laws)*
  - *Epistemological condition of Scientific Knowledge (hypotheses)*
  - *Epistemological condition of Scientific Knowledge (theories)*

Data Analysis and Statistical Techniques Employed

In order to determine the characteristics as to the academic level of the preservice teachers who participated in the study, a descriptive statistical analysis was conducted. In this analysis, third and fourth grade preservice teachers taking part in the lesson, *"The Nature of Science and Science History"* and their first and second grade counterparts were grouped. The data obtained from the descriptive statistics in the academic level factor and the data obtained from the answers which the preservice teachers gave to the eight articles of the BDTÜG questionnaire were analyzed using the SPSS 21.0 Statistics Program. In the analysis of the data, frequency (f), percentage (%) and x-square test were used.

The options of the questionnaire used in the study were classified as *"realistic," "acceptable"* and *"insufficient,"* as used by Rubba et al. (1996). For this, the questionnaire was examined by eight competent scientists with prior knowledge of physics, chemistry, biology, and education, and the classification of each question was determined by examining the frequency of the classification which they performed. The classification of the questionnaire conducted by the specialists is shown in Table 2.

Table 2. *Coding scale used in evaluation of BDTÜG questionnaire*

BDTÜG Questionnaire Questions / Options	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Definition of Science	A	A	R	A	İ	A	A	İ
Relationship of Science and Technology	İ	R	A	A	İ			
Effect of Science and Technology on Solution of Social Problems	A	R	R	A	İ	İ		
Changeability of Scientific Knowledge	R	R	A	İ				
Hypotheses, Theories, and Laws	İ	İ	İ	A	R			
Epistemological Condition of Scientific Knowledge (laws)	İ	İ	A	A	R			
Epistemological Condition of Scientific Knowledge (hypotheses)	İ	İ	A	İ	A	R		
Epistemological Condition of Scientific Knowledge (theories)	İ	İ	A	İ	R	R		

In Table 2, the realistic view is shown as "R," the acceptable view is shown as "A," and the insufficient view is shown as "İ."

FINDINGS

In this part of the study, the findings obtained through statistical analysis from the data are presented in tables, and comments concerning the findings are also mentioned. Also included are findings as to the results of the answers given to the eight articles of the questionnaire and the results of the *x*-square analysis of these findings.

Table 3. *Definition of science*

Defining science is difficult because science is complex and does many things. But MAINLY science is:	f	%
REALISTIC	98	40.5
C. Exploring the unknown and discovering new things about our world and universe and how they work.	98	40.5
ACCEPTABLE	132	54.5
A. Study of fields such as biology, chemistry and physics.	4	1.7
B. Body of knowledge such as principles, laws and theories, which explain the world around us (matter, energy and life).	61	25.2
D. Carrying out experiments to solve problems of interest about the world around us.	4	1.7
F. Finding and using knowledge to make this world a better place to live in (for example, curing diseases, solving pollution and improving agriculture).	55	22.7
G. An organization of people (called scientists) who have ideas and techniques for discovering new knowledge.	8	3.3
INSUFFICIENT	12	5.0
E. Inventing or designing things (for example, artificial hearts, computers, space vehicles).	5	2.1
H. No one can define science	3	1.2
OTHER ANSWERS (classified as insufficient)	4	1.7
Realistic: 40.5% (f=98) Acceptable: 54.5% (f=132) Insufficient: 5% (f=12)		

According to Table 3, preservice teachers made no common argument as to what science is. In total, 54.5% of the preservice teachers marked options A, B, D, F, and G in the category of acceptable view. In this category, the most marked options were B (25.2%) and F (22.7%). The most preferred option concerning the definition of science was C ("Searching the unknown is to explore the new things as to our world and universe and how these function") with a percentage of 40.5% and was in the category of realistic view. However, 5% of the preservice teachers marked options in the insufficient view category, with option

E (2.1%), H (1.2%) and "Other Answers" that totaled 1.7% as the least marked options in the insufficient category. It can be seen that a significant proportion considered science as "answering questions concerning the natural world, searching the unknown, and the effort to reach the necessary information to make the world a better place to live in."

Table 4. *Relationship between science and technology*

Technologists have their own body of knowledge to build on. Few developments in technology have come directly from discoveries made in science.	*f*	%
REALISTIC	88	36.4
B. Technology advances by relying equally on both scientific discoveries and technology's own body of knowledge.	57	23.6
EVERY technological development builds on a scientific discovery: E. Because science provides the background information and the new ideas for technology.	31	12.8
ACCEPTABLE	132	54.5
C. Both scientists and technologists depend on the same body of knowledge, because science and technology are so similar.	69	28.5
EVERY technological development builds on a scientific discovery: D. Because scientific discoveries always find a use, whether for technological developments or for other scientific uses.	63	26.0
INSUFFICIENT	22	9.1
A. Technology advances **mainly** on its own. It doesn't necessarily need scientific discoveries.	15	6.2
OTHER ANSWERS (classified as insufficient)	7	2.9
Realistic: 36.4% (f=88) Acceptable: 54.5% (f=132) Insufficient: 9.1% (f=22)		

According to Table 4, 54.5% of the preservice teachers marked acceptable view answers, with either options C (28.5%) or D (26%) to the question of the relationship between science and technology. In this question, 36.4% of the preservice teachers marked options B (23.6%) or E (12.8%) in the category of realistic view. Moreover, 9.1% of the preservice teachers marked either option A (6.2%) or "Other Answers" which totaled 2.9% as the least marked options in the insufficient category. The preservice teachers were of the opinion that science and technology are similar to each other, and that the knowledge of people dealing with science improves depending on the explorations in science.

Table 5. *Changeability of scientific knowledge*

Even when scientific investigations are done correctly, the knowledge that scientists discover from those investigations may change in the future. Scientific knowledge changes:	*f*	%
REALISTIC	206	85.1
A. Because new scientists disprove the theories or discoveries of old scientists. Scientists do this by using new techniques or improved instruments, by finding new factors overlooked before, or by detecting errors in the original "correct" investigation.	115	47.5
B. Because the old knowledge is reinterpreted in light of new discoveries. Scientific facts can change.	91	37.6
ACCEPTABLE	27	11.2
C. Scientific knowledge APPEARS to change because the **interpretation** or the application of the old facts can change. Correctly done experiments yield unchangeable facts.	27	11.2
INSUFFICIENT	9	3.7
D. Scientific knowledge APPEARS to change because new knowledge is **added on to** old knowledge; the old knowledge doesn't change.	6	2.5
OTHER ANSWERS (classified as insufficient)	3	1.2
Realistic: 85.1% (f=206) Acceptable: 11.2% (f=27) Insufficient: 3.7% (f=9)		

When examining Table 5, it can be seen that 85.1% of the preservice teachers marked option A (47.5%) or B (37.6%) in the category of realistic view on the question concerning the changeability of the scientific question. In the category of acceptable view, 11.2% of the preservice teachers marked option C. It can also be seen that option D (2.5%) and the "Other Answers" which totaled just 0.8% as the least marked options in the insufficient category by the preservice teachers. The results indicate that preservice teachers are aware of the fact that science is not a constant and that it can change with time.

Table 6. *Effect of science and technology on the solution of social problems*

Science and technology offer a great deal of help in resolving such social problems as pollution and overpopulation.	*f*	%
REALISTIC	93	38.4
B. Science and technology can help resolve some social problems but not others.	29	12.0
C. Science and technology solve many social problems, but science and technology also cause many of these problems.	64	26.4
ACCEPTABLE	119	49.2
A. Science and technology can certainly help to resolve these problems. The problems could use new ideas from science and new inventions from technology.	65	26.9
D. It's not a question of science and technology helping. But rather it's a question of people using science and technology wisely.	54	22.3
INSUFFICIENT	30	12.4
E. It's hard to see how science and technology could help very much in resolving these social problems. Social problems concern human nature; these problems have little to do with science and technology.	27	11.2
F. Science and technology only make social problems worse. It's the price we pay for advances in science and technology.	1	0.4
OTHER ANSWERS (classified as insufficient)	2	0.8
Realistic: 38.4% (f=93) Acceptable: 49.2% (f=119) Insufficient: 12.4% (f=30)		

When Table 6 is examined, it can be seen that 49.2% of the preservice teachers marked either options A (26.9%) or D (22.3%) in the category of acceptable view in the question concerning searching for the effect of science and technology in the solution of social problems. On this question, 38.4% of the preservice teachers marked either options B (12.0%) or C (26.4%) in the category of realistic view. It is also seen that the options of E (11.2%), F (0.4%) and the "Other Answers" which totaled just 0.8% as the least marked options in the insufficient category by the preservice teachers. As can be seen, the preservice teachers both believe that science and technology will cause social problems and that they may lead to these kind of problems. In addition, the number of preservice teachers who believe that the real problem is that science and technology is not used within logic was as many as not to be ignored.

Table 7. *Hypotheses, theories and laws*

Scientific ideas develop from hypotheses to theories, and finally, if they are good enough, to being scientific laws. Hypotheses can lead to theories which can lead to laws:	*f*	%
REALISTIC	45	18.6
E. Theories can't become laws because they both are different types of ideas. Laws describe things in general. Theories explain these laws. However, with supporting evidence, hypotheses may become theories (explanations) or laws (descriptions).	45	18.6
ACCEPTABLE	44	18.2
D. Theories can't become laws because they both are different types of ideas. Theories are based on scientific ideas which are less than 100% certain, and so theories **can't** be proven true. Laws, however, are based on facts only and are 100% sure.	44	18.2
INSUFFICIENT	153	63.2
A. Because an hypothesis is tested by experiments, if it proves correct, it becomes a theory. After a theory has been proven true many times by different people and has been around for a long time, it becomes a law.	81	33.5
B. Because an hypothesis is tested by experiments, if there is supporting evidence, it's a theory. After a theory has been tested many times and seems to be essentially correct, it's good enough to become a law.	59	24.4
C. Because it is a logical way for scientific ideas to develop.	10	4.1
OTHER ANSWERS (classified as insufficient)	3	1.2
Realistic: 18.6% (f=45) Acceptable: 18.2% (f=44) Insufficient: 63.2% (f=153)		

When examining Table 7, it can be seen that 63.2% of the preservice teachers marked options A (33.5%), B (24.4%), or C (4.1%), or "Other Answers" which totaled 1.2% as the least marked options in the category of insufficient view for the question concerning hypotheses, theories, and laws. For the category of realistic view, 18.6% of the preservice teachers marked option E. Similarly, in the category of acceptable view, 18.2% of the preservice teachers marked option D. The results indicate that 57.9% of the preservice teachers believe that the conventional hierarchy of hypotheses-theory-law is true. However, in modern science, it is said that such a relationship among hypotheses-theory-law does not exist. It is significant that academicians and preservice teachers' pay attention to this issue.

Table 8. *Epistemological condition of scientific knowledge (laws)*

For this statement, assume that a gold miner "discovers" gold while an artist "invents" a sculpture. Some people think that scientists discover scientific LAWS. Others think that scientists invent them. What do you think?	*f*	%
REALISTIC	46	19.0
E. Scientists invent laws, because scientists interpret the experimental facts which they discover. Scientists don't invent what nature does, but they do invent the laws which describe what nature does.	46	19.0
ACCEPTABLE	88	36.4
C. Scientists discover scientific laws: but scientists invent the methods to find those laws.	35	14.5
D. Some scientists may stumble onto a law by chance, thus discovering it. But other scientists may invent the law from facts they already know.	53	21.9
INSUFFICIENT	108	44.6
A. Scientists discover scientific laws: because the laws are out there in nature and scientists just have to find them.	78	32.2
B. Scientists discover scientific laws: because laws are based on experimental facts.	22	9.1
OTHER ANSWERS (classified as insufficient)	8	3.3
Realistic: 19.0% (f=46) Acceptable: 36.4% (f=88) Insufficient: 44.6% (f=108)		

According to Table 8, on the question concerning the epistemological condition (laws) of scientific knowledge in the questionnaire, 44.6% of the preservice teachers marked options A (32.2%) or B (9.1%) in the category of insufficient view, or "Other Answers" which totaled 3.3% as the least marked options in the insufficient category by the preservice teachers. Additionally, 36.4% marked options C or D in the category of acceptable view, and 19% marked option E in the category of realistic view. Viewed overall, concerning the epistemological condition (laws) of scientific knowledge, it is seen that some of the preservice teachers (32.2%) have ideas that laws exist in nature and scientists have discovered them; whereas some (21.9%) hold traditional views they were invented by suggesting that scientists have discovered hypotheses either coincidentally or based on the facts which they already knew.

Table 9. *Epistemological Condition of Scientific Knowledge (Hypotheses)*

For this statement, assume that a gold miner "discovers gold" while an artist "invents" a sculpture. Some people think that scientists discover scientific HYPOTHESES. Others think that scientists invent them. What do you think?	*f*	%
REALISTIC	19	7.9
F. Scientists invent a hypothesis, because inventions (hypotheses) come from the mind, we create them.	19	7.9
ACCEPTABLE	88	36.4
C. Scientists discover a hypothesis, but scientists invent the methods to find the hypothesis.	56	23.1
E. Scientists invent a hypothesis, because a hypothesis is an interpretation of experimental facts which scientists have discovered.	32	13.2
INSUFFICIENT	135	55.8
A. Scientists discover a hypothesis, because the idea was there all the time to be uncovered.	37	15.3
B. Scientists discover a hypothesis, because it is based on experimental facts.	27	11.2
D. Some scientists may stumble onto a hypothesis by chance, thus discovering it. But other scientists may invent the hypothesis from facts they already know.	56	23.1
OTHER ANSWERS (classified as insufficient)	15	6.2
Realistic: 7.9% (f=19) Acceptable: 36.4% (f=88) Insufficient: 55.8% (f=135)		

When Table 9 is examined for the question concerning the epistemological condition (hypotheses) of scientific knowledge, it can be seen that 55.8% of the preservice teachers marked options A (15.3%), B (11.2%), or D (23.1%) in the category of insufficient view, or "Other Answers" which totaled 6.2% as the least marked options in the insufficient category by the preservice teachers. Also, 36.4% of the preservice teachers marked options C (23.1%) or E (13.2%) in the category of acceptable view, with 7.9% having marked option F in the category of realistic view. Here, it could be said that the majority of the preservice teachers hold unmodern views concerning the epistemological condition (hypotheses) of scientific knowledge. The preservice teachers were of the opinion that hypotheses are discovered because the idea existed in nature and was awaiting discovery; on the other hand, some thought that scientists discovered hypotheses either coincidentally or based on the facts which they already knew.

Table 10. *Epistemological condition of scientific knowledge (theories)*

For this statement, assume that a gold miner "discovers" gold while an artist "invents" a sculpture. Some people think that scientists discover scientific THEORIES. Others think that scientists invent them. What do you think?	*f*	%
REALISTIC	64	26.4
E. Scientists invent a theory: because a theory is an interpretation of experimental facts which scientists have discovered.	47	19.4
F Scientists invent a theory: because inventions (theories) come from the mind we create them.	17	7.0
ACCEPTABLE	51	21.1
C. Scientists discover a theory: but scientists invent the methods to find the theories.	51	21.1
INSUFFICIENT	127	52.5
A. Scientists discover a theory: because the idea was there all the time to be uncovered..	34	14.0
B Scientists discover a theory: because it is based on experimental facts.	35	14.5
D. Some scientists may stumble onto a theory by chance, thus discovering it. But other scientists may invent the theory from facts they already know.	47	19.4
OTHER ANSWERS (classified as insufficient)	11	4.5
Realistic: 26.4% (f=64) Acceptable: 21.1% (f=51) Insufficient: 52.5% (f=127)		

When Table 10 is analyzed, for the question concerning the epistemological condition (theories) of scientific knowledge, 52.5% of the preservice teachers marked options A (14.0%), B (14.5%), or D (19.4%) in the category of insufficient view, or "Other Answers" which totaled 4.5% as the least marked options in the insufficient category by the preservice teachers. Also, 26.4% of the preservice teachers marked options E (19.4%) or F (7.0%) in the category of realistic view, and 21.1% marked option C in the category of acceptable view. The results show that the preservice teachers have similar ideas; in other words, an unmodern point of view as to the hypotheses and laws of the previous two questions concerning the epistemological condition (theories) of scientific knowledge.

Table 11. *X-square test analysis according to academic level factor*

Question No.	*First and Second Grade (84)*						*Third and Fourth Grade (158)*						*x-Square*	
	Realistic		*Acceptable*		*Insufficient*		*Realistic*		*Acceptable*		*Insufficient*			
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	X^2	*P*
1	32	38.1	49	58.3	3	3.6	66	41.8	83	52.5	9	5.7	1.021	.600
2	32	38.1	45	53.6	7	8.3	56	35.4	87	55.1	15	9.5	.210	.900
3	28	33.3	37	44.0	19	22.6	65	41.1	82	51.9	11	7.0	12.402	.002
4	70	83.3	10	11.9	4	4.8	136	86.1	17	10.8	5	3.2	.489	.783
5	4	4.8	11	13.1	69	82.1	41	25.9	33	20.9	84	53.2	22.355	.000
6	13	15.5	25	29.8	46	54.8	33	20.9	63	39.9	62	39.2	5.347	.069
7	1	1.2	21	25.0	62	73.8	18	11.4	67	42.4	73	46.2	19.332	.000
8	23	27.4	12	14.3	49	58.3	41	25.9	39	24.7	78	49.4	3.696	.158

According to the answers which the preservice teachers gave to the questions in the academic level questionnaire of BDTÜG, the results of x-square analysis are shown in Table 11.

In the first question, it was noted that there was no meaningful difference between the views of the first and second grade, and the third and fourth grade preservice teachers concerning *views concerning the definition of science* (X^2=1.021; p=.600 > .05).

In the second question, it was noted that there was no meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the relationship of the inventions in science with the developments in technology* (X^2=.210; p=.900 > .05).

In the third question, it was noted that there was a meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the effect of science and technology on the solutions of social problems* (X^2= 12.402; p=.002 < .05). In Table 10, it can be seen that the third and fourth grade preservice teachers have more acceptable and realistic views and less insufficient views compared with the first and second grade preservice teachers.

In the fourth question, it was noted that there was no meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the changeability of scientific knowledge* (X^2=.489; p=.783 > .05).

In the fifth question, it was noted that there was a meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *hypotheses, laws and theories* (X^2=22.355; p=.000 < .05). In Table 10, it can be seen that the third and fourth grade preservice teachers have more acceptable and realistic views than insufficient views compared with the first and second grade preservice teachers.

In the sixth question, it was noted that there was no meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the epistemological condition of the scientific knowledge (laws)* (X^2=5.347; p=.069 > .05).

In the seventh question, it was noted that there was a meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the epistemological condition of the scientific knowledge (hypotheses)* (X^2=19.332; p=.000 < .05). In Table 10, concerning *the epistemological condition of the scientific knowledge (hypotheses),* it can be seen that the third and fourth grade preservice teachers have more acceptable and realistic views than insufficient views compared with the first and second grade preservice teachers.

In the eighth question, it was noted that there was no meaningful difference between the views of the first and second grade, and third and fourth grade preservice teachers concerning *the epistemological condition of the scientific knowledge (theories)* (X^2=3.696; p=.158 > .05).

DISCUSSION, RESULT AND SUGGESTIONS

In this study, the points of view of preservice teachers from the Science Teaching Department concerning the definition of science in the subjects of the nature of science, the relationship of science and technology, the effect of science and technology on solving social problems, the changeability of scientific knowledge, hypotheses, theories and laws and the epistemological condition of scientific knowledge, and the relationship of these views with academic level were interpreted with the support of current conceptual literature.

From the answers given to the first question, it was noted that the preservice teachers held very different views for the definition of science. Although 40.5% of the preservice teachers significantly hold a realistic view that *"Searching for the unknown is to explore new things concerning our world and universe and how they function"* in the first question of the questionnaire, 54.5% hold more acceptable views. This result is similar to the results of research conducted at different times (Aikenhead, 1987; Arı, 2010; Aslan, 2009; Beşli, 2008; Doğan Bora, 2005; Erdoğan, 2004; Haidar, 1999; Kenar, 2008; Özbudak, 2010; Rubba & Harkness, 1993; Saraç, 2012). It was noted in these results that teachers and preservice teachers do not hold realistic views towards the definition of science.

From the answers given to the second question, which searches for the effect of inventions in science on the developments in technology and examines the relationship between science and technology, it was noted that 54.5% of the preservice teachers held an acceptable point of view, which advocates that *"science and technology is dependent on the same knowledge and is quite similar to each other."* It was also noted that 36.4% of the preservice teachers hold a realistic point of view, which is *"Technology develops by equally depending on inventions and its own knowledge as science provides new ideas and basic knowledge for technology."* It could be said that preservice teachers are aware of the fact that technological developments improve with scientific inventions; and in parallel with this, scientific inventions improve with technological developments.

In the third question, searching the effect of science and technology on the solution of social problems, it can be seen that 49.2% and 38.4% of the preservice teachers have a point of view reflecting the views in the acceptable and realistic categories, respectively. The preservice teachers believe that science and technology will help solve social problems such as pollution and excessive population growth when people use them within reason. At the same time, they also state that while trying to solve some problems like these, they can also create some of these problems as well.

In the fourth question on the changeability of scientific knowledge, which is *"even if the scientific researches are carried out correctly, the knowledge scientists obtained through these research could change in the future,"* the majority of the preservice teachers (85.1%) hold a realistic view. The preservice teachers stated their realistic views showing that scientific knowledge changes as it can be reinterpreted and disprove the old theories in the light of new findings by scientists using new techniques and sophisticated instruments. This result bears similarities to other research in which this characteristic concerning the nature of science was measured in the literature (Aslan, 2009; Beşli, 2008; Doğan Bora, 2005; Saraç, 2012).

As to the fifth question regarding *"scientific ideas evolve from hypotheses to theories, and eventually turn into scientific laws,"* which searches for the structure of hypotheses, theories and laws, it was noticed that 63.2% of the preservice teachers hold a view in the category of insufficient. This view favors a hierarchic structure from hypotheses towards laws in scientific knowledge, which unfortunately reflects the views of a significant part of the "condition could be explained through misbelief" expressed by McComas (2000), that there is a hierarchic structure to scientific ideas. However, hypotheses, theories and laws are different information. The conceptual fallacy that there is a hierarchy among hypotheses, theories and laws appears quite often in the literature (Abd-El Khalick, 2006; Aslan, 2009; Doğan Bora, 2005; Erdoğan, 2004; Kenar, 2008; Liu & Lederman, 2007; Saraç, 2012; Tatar, Karakuyu, & Tüysüz, 2011). The fact that 18.6% of the preservice teachers hold a realistic view expressing that theories and laws are different forms of scientific knowledge and that these cannot turn into each other reveal that they hold incorrect beliefs concerning the structure of hypotheses, theories and laws.

In the sixth, seventh, and eighth questions of the questionnaire concerning the epistemological condition of scientific knowledge, it was noted that the preservice teachers hold views which are not realistic. The preservice teachers suggested unrealistic views expressing that scientific laws (44.6% insufficient and 36.4% acceptable), scientific hypotheses (55.8% insufficient and 36.4% acceptable), and scientific theories (52.5% insufficient and 21.1% acceptable) were always waiting in nature to be discovered and that scientists unearthed and/or invented them. Similar results to these conditions are seen in other studies as well (Aslan, 2009; Doğan Bora, 2005; Erdoğan, 2004; Haidar, 1999; Ryan & Aikenhead, 1992; Saraç, 2012). The most important reason why preservice teachers hold these insufficient views could be either the common use of such incorrect views in course books and science education, or the inadequate coverage of the necessary information (Aikenhead & Ryan, 1992; McComas, 2000).

A comparison on an academic scale was conducted between first and second grade, and third and fourth grade preservice science teachers. In the third, fifth, and seventh questions of the questionnaire, a meaningful relationship was established according to academic level factor. There were no meaningful differences in the other questions in statistical terms. The third and fourth grade preservice science teachers held more realistic views compared with first and second grade preservice science teachers concerning *"the effect of science and technology on the solution of social problems, hypotheses, theories and laws, and the epistemological condition scientific knowledge (hypotheses),"* which is one of the issues of the nature of science. The fact that preservice teachers showed no difference in terms of their academic level, except for these three articles may be attributed to result-oriented educational programs which they have experienced so far and course books offering practice based on memorization.

The following suggestions are put forward based on the findings from this study.

In this study, it was noted that preservice science teachers have more unmodern views in the dimensions of the nature of science. New studies could be performed in order to attempt to change and improve the views of preservice teachers as to the nature of science.

It is significant that academic staff have an improved perception of the nature of science, adopt the perspectives of modern science, follow technology closely, and be science-literate professionals who can develop appropriate activities in terms of conveying their knowledge to preservice teachers. In this respect, academic staff could be given in-service training.

While studying lessons such as the Nature of Science and Science History, included in the educational programs for teacher training, the studies in which the views of preservice teachers concerning the nature of science and the scientific knowledge are determined must be taken into consideration.

More studies should be conducted towards determining the views of teachers and preservice teachers as to the nature of science, and materials which could be used in teaching the nature of science within the scope of the findings of this study must be developed.

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